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MEETING ABSTRACT

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# Brain blood flow and hyperventilation on cold water immersion: can treading water help control these symptoms of cold shock?

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## Introduction

Cold-water immersion (CWI) elicits the cold shock response (CSR). The hyperventilatory component of the CSR causes a decrease in cerebral blood flow velocity (CBFv) potentially causing sensations of dizziness and increasing the risk of becoming unconscious and consequently drowning [1]. In these early minutes of CWI the current advice is to 'float first' and remain stationary [2] yet this strategy may not have any effect on ventilation and therefore brain CBFv. We tested the hypothesis that leg only exercise could offset the reduction in CBFv in a resting CWI ( $H_1$ ) and be absent in warm water immersion.

## Methods

Seventeen participants consented and visited the laboratory 3 times; mean [SD]: age 21 [3]yrs; height 1.71 [.01] m; mass 70.9 [10.1]kg. All immersions were standardised

by depth, duration, clothing (bathing suit) and time of day. Test conditions were a) a resting warm water immersion (WWI; 34.7 [2.6] °C), b) a resting CWI (CWI-R: 12.2 [0.5] °C), c) a CWI (12.1 [0.5] °C) where light exercise (leg kicking/treading water; 80 bpm<sup>-1</sup>) commenced 30-seconds after water entry (CWI-K). CBFv was measured using a transcranial Doppler at a fixed depth (61 [1] mm) over the middle cerebral artery. Oxygen uptake and ventilation were measured using an online gas analysis system. Perceptions of breathlessness were measured after 1, 3 and 5 minutes using an 11-point categorical scale (0-not at all breathless, 10-extremely breathless). ANOVA was used to analyse the data to an alpha level of 0.05.

## Results

CWI induced significant changes in contrast to WWI (see Table 1).

**Table 1 Mean [SD] perceived breathlessness, CBFv, oxygen uptake, and carbon dioxide production in WWI (condition a), CWI-R (b) and CWI-K (c); letters denote differences between the corresponding condition.**

	CBFv (Δ%)			VO <sub>2</sub> (mL.kg <sup>-1</sup> .min <sup>-1</sup> )			VCO <sub>2</sub> (mL.kg <sup>-1</sup> .min <sup>-1</sup> )		
	WWI <sup>a</sup>	CWI-R <sup>b</sup>	CWI-K <sup>c</sup>	WWI <sup>a</sup>	CWI-R <sup>b</sup>	CWI-K <sup>c</sup>	WWI <sup>a</sup>	CWI-R <sup>b</sup>	CWI-K <sup>c</sup>
PRE	-	-	-	387[96]	407[58]	405[90]	335[80]	377[75]	365[87]
1 MIN	5[4] <sup>b</sup>	-6[9] <sup>a</sup>	-3[16]	633[117] <sup>c</sup>	671[129]	692[137] <sup>a</sup>	518[97] <sup>b,c</sup>	837[253] <sup>a</sup>	880[343] <sup>a</sup>
2 MIN	3[6] <sup>b</sup>	-6[9] <sup>a</sup>	2[20]	424[84] <sup>c</sup>	437[94] <sup>c</sup>	534[89] <sup>a,b</sup>	375 [79] <sup>c</sup>	482[212] <sup>c</sup>	623[216] <sup>ab</sup>
3 MIN	3[4]	1[10]	3[16]	390[76] <sup>bc</sup>	432[84] <sup>ac</sup>	537[79] <sup>a,b</sup>	347 [76] <sup>c</sup>	405[173] <sup>c</sup>	497[133] <sup>ab</sup>
4 MIN	3[4]	7[11]	8 [21]	359[66] <sup>bc</sup>	436[101] <sup>ac</sup>	543[84] <sup>a,b</sup>	321[60] <sup>c</sup>	368[135] <sup>c</sup>	460[120] <sup>ab</sup>
5 MIN	5[6]	7[10]	4[17]	362[72] <sup>bc</sup>	454 [85] <sup>ac</sup>	570[99] <sup>ab</sup>	322[66] <sup>c</sup>	372[108] <sup>c</sup>	455[99] <sup>ab</sup>

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## Discussion

Leg kicking on CWI partially offset the reduction in CBFv that normally occurs on CWI; in contrast to a warm water control. WWI CBFv was only different to the CWI-R condition. This did not alleviate symptoms of breathlessness despite increased oxygen uptake and carbon dioxide production in the CWI-K condition; the hypothesis is only partially supported.

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